DIRECT NUMERICAL SIMULATIONS OF TURBULENT VISCOELASTIC CHANNEL FLOW: TOWARDS A BETTER UNDERSTANDING OF POLYMER-INDUCED DRAG REDUCTION

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The recent progress in understanding the mechanism of polymer-induced drag reduction in turbulent viscoelastic flows through large scale spectral simulations is going to be presented. High performance computations have helped us generate reliable data for the average and various turbulence statistics for the turbulent channel flow of a dilute viscoelastic polymer solution modeled from first principles with the FENE-P differential constitutive equation.

In particular, our most recent data have helped us elucidate the dependence of drag reduction on the Weissenberg number: Drag reduction sets in at a critical value of the Weissenberg number (about 8 for the FENE-P model used here) and continues increasing, albeit at a lower rate, even at the highest value examined (125) asymptotically approaching a value more than 30% for the values of the molecular extensibility studied. Furthermore, as the molecular extensibility increases and as the polymer concentration increases, the drag reduction also increases. In contrast, it was found that for given flow elasticity, corresponding to a fixed friction Weissenberg number, the drag reduction remains practically unchanged as the friction Reynolds number increases from 125 to 590.